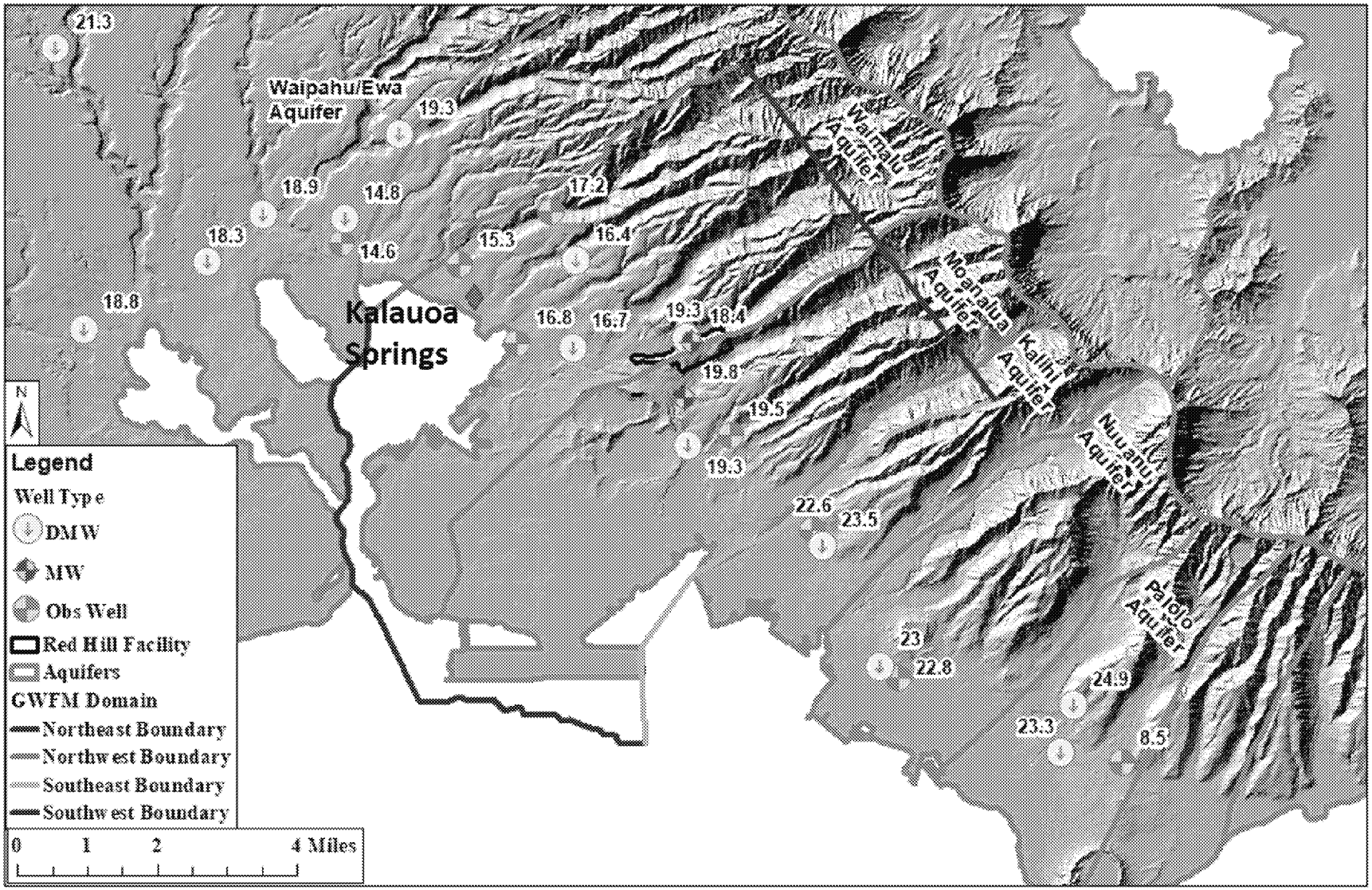
DOH SWPP GWFM Concerns

1. GWFMs use boundary conditions that come with a lot of uncertainty, resulting in model result uncertainty
2. Lack of verifiable metrics to ensure the model replicates hydrogeologic dynamics with sufficient certainty
   a) Local metrics
   b) Regional metrics
3. The application to date of the model conclusions is problematic.
   a) Critical question: can pumping the RHS at 4.6 mgd capture of otherwise immobilize a fugitive contaminant plume?

Critical Drinking Water Risk Evaluation Questions

- Does pumping the Red Hill Shaft mobilize groundwater from beneath the tanks in a direction that is down the axis of the Red Hill Ridge?
- Is there a hydraulic pathway from beneath the tanks to the Halawa Shaft?
- Over-arching question; is the model informative for answering either of both of those questions?

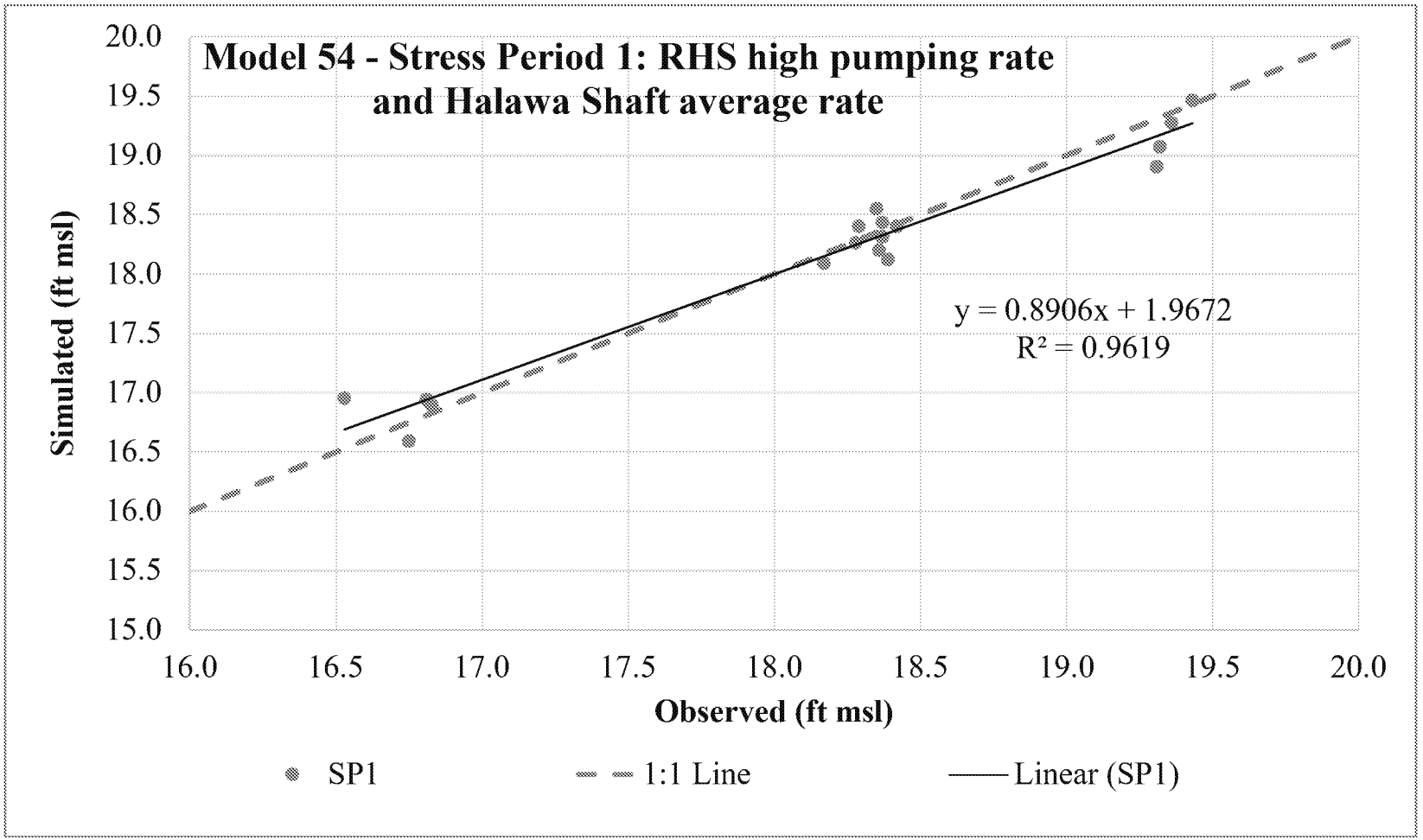
GWFM Boundary Conditions



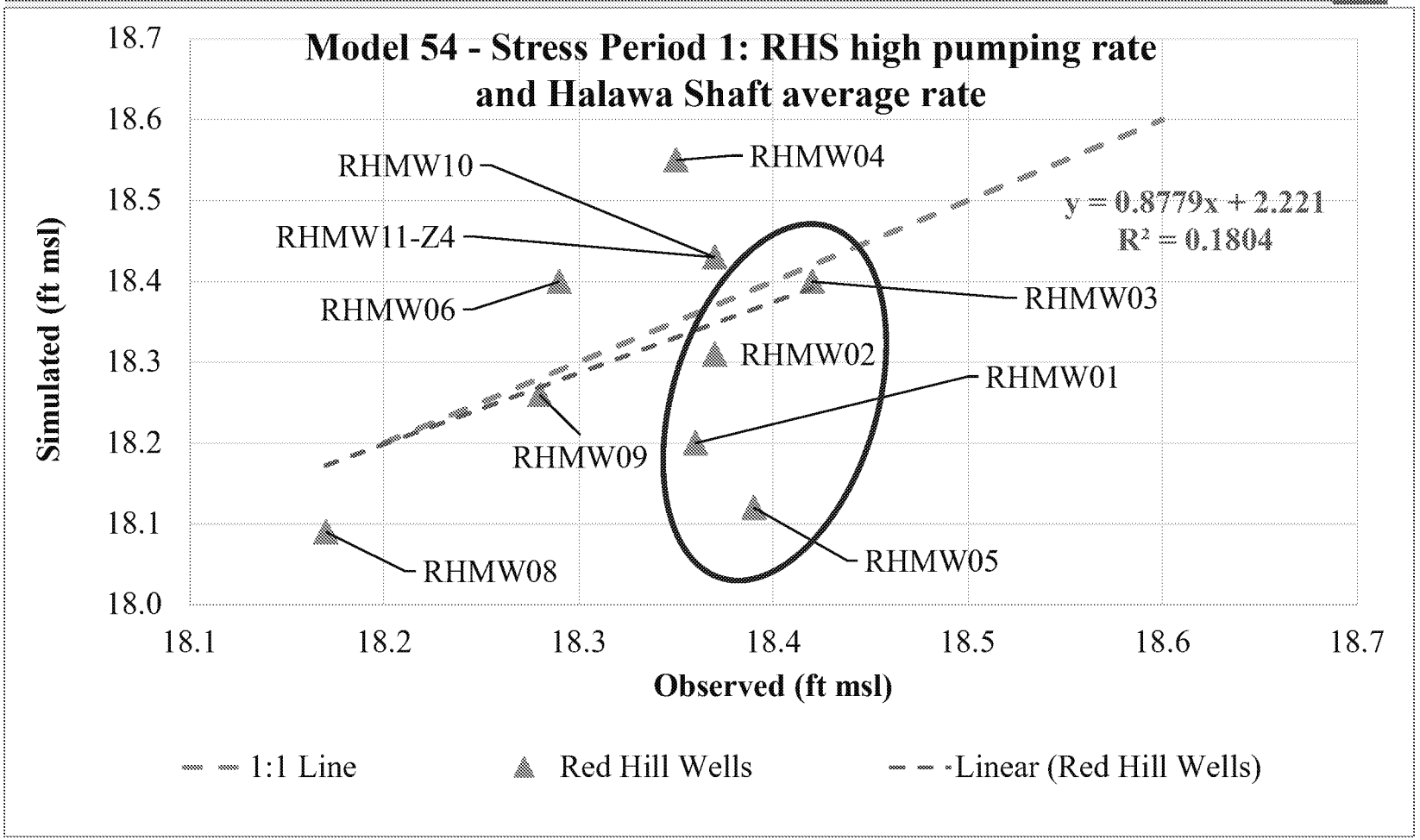
Model Verification Metrics

1. Metrics currently used
2. Issues with current metrics
3. Alternatives

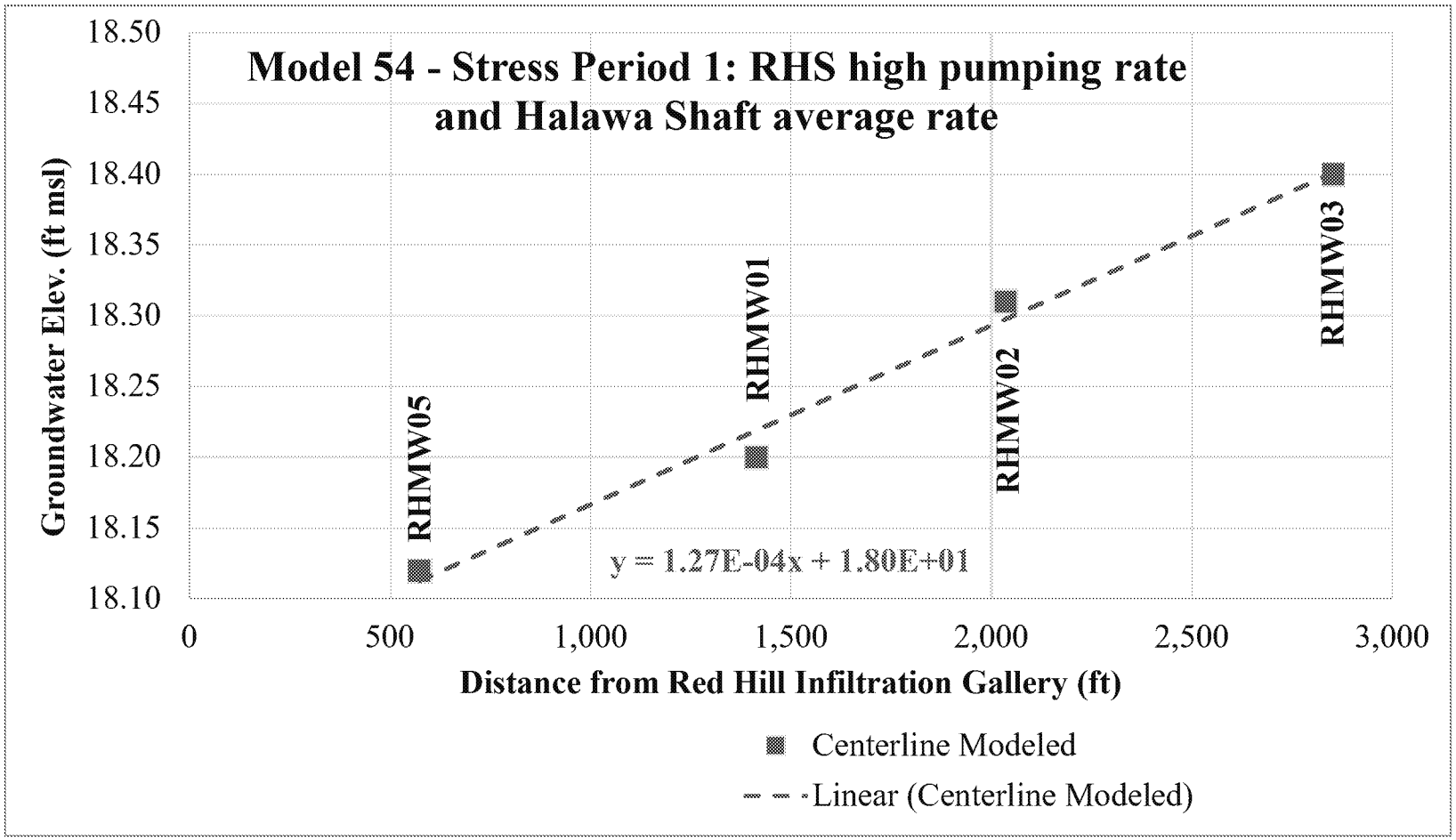
Lack of Verifiable Metrics



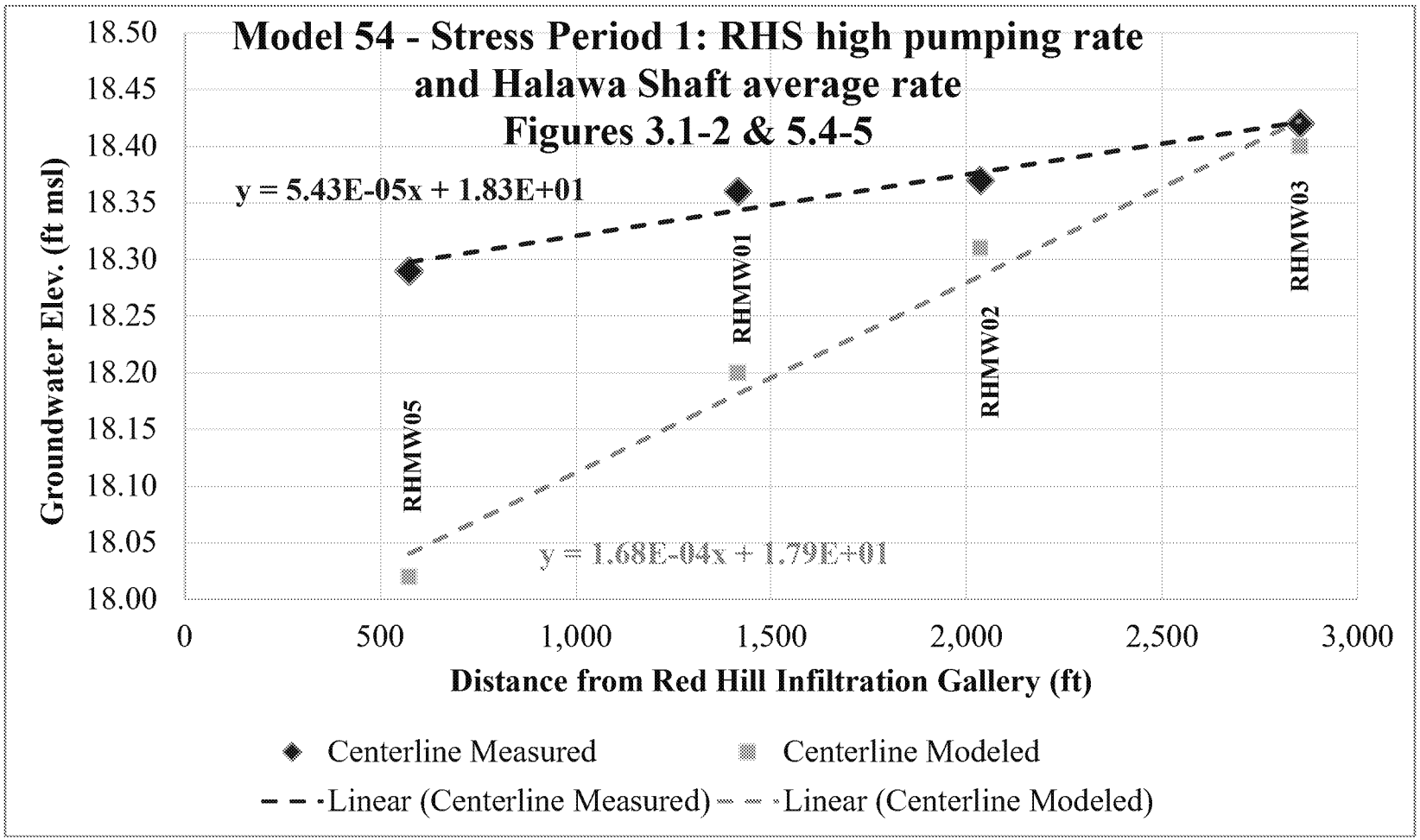
Lack of Verifiable Metrics



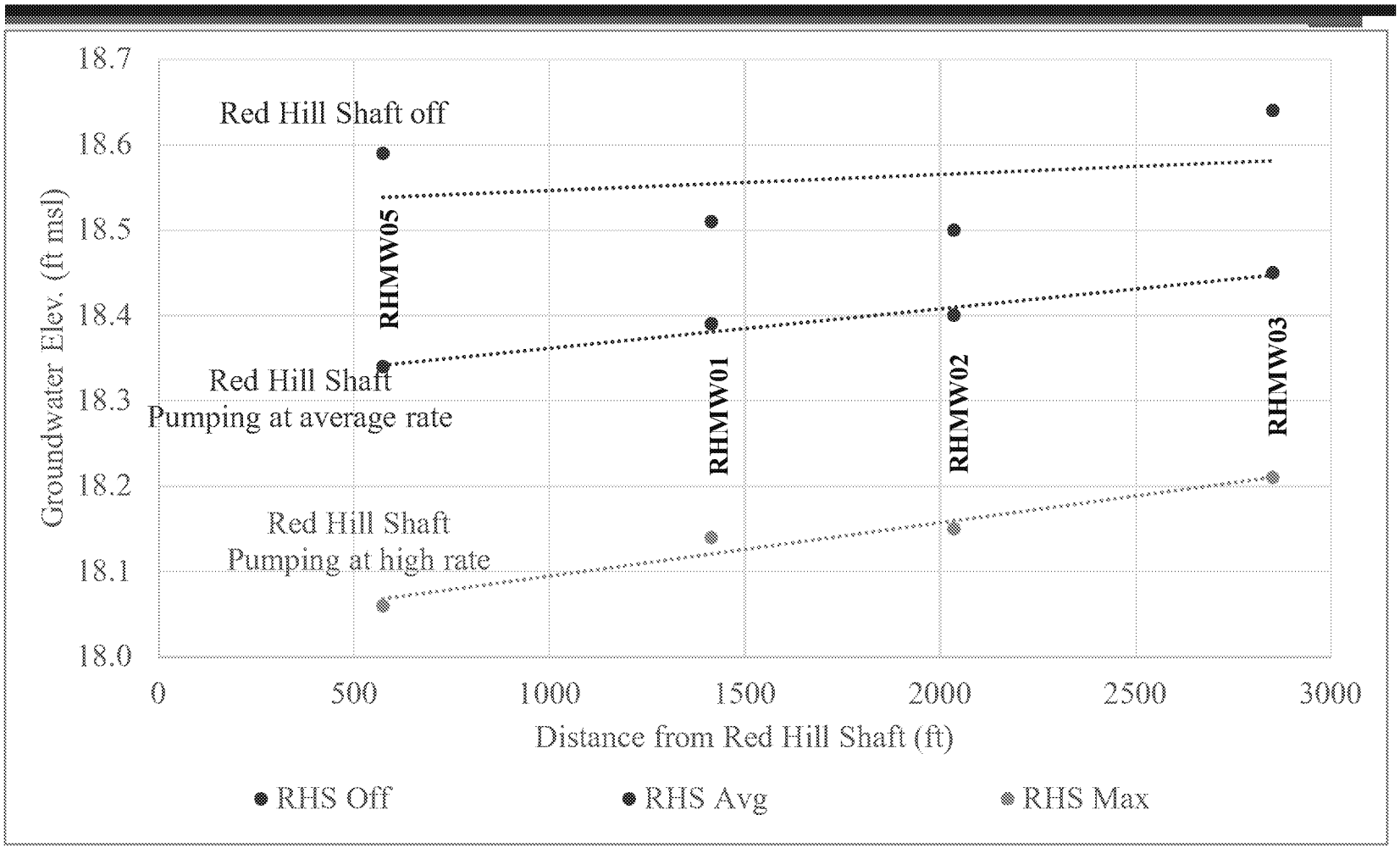
Modeled Gradient



Measured gradient vs modeled gradient



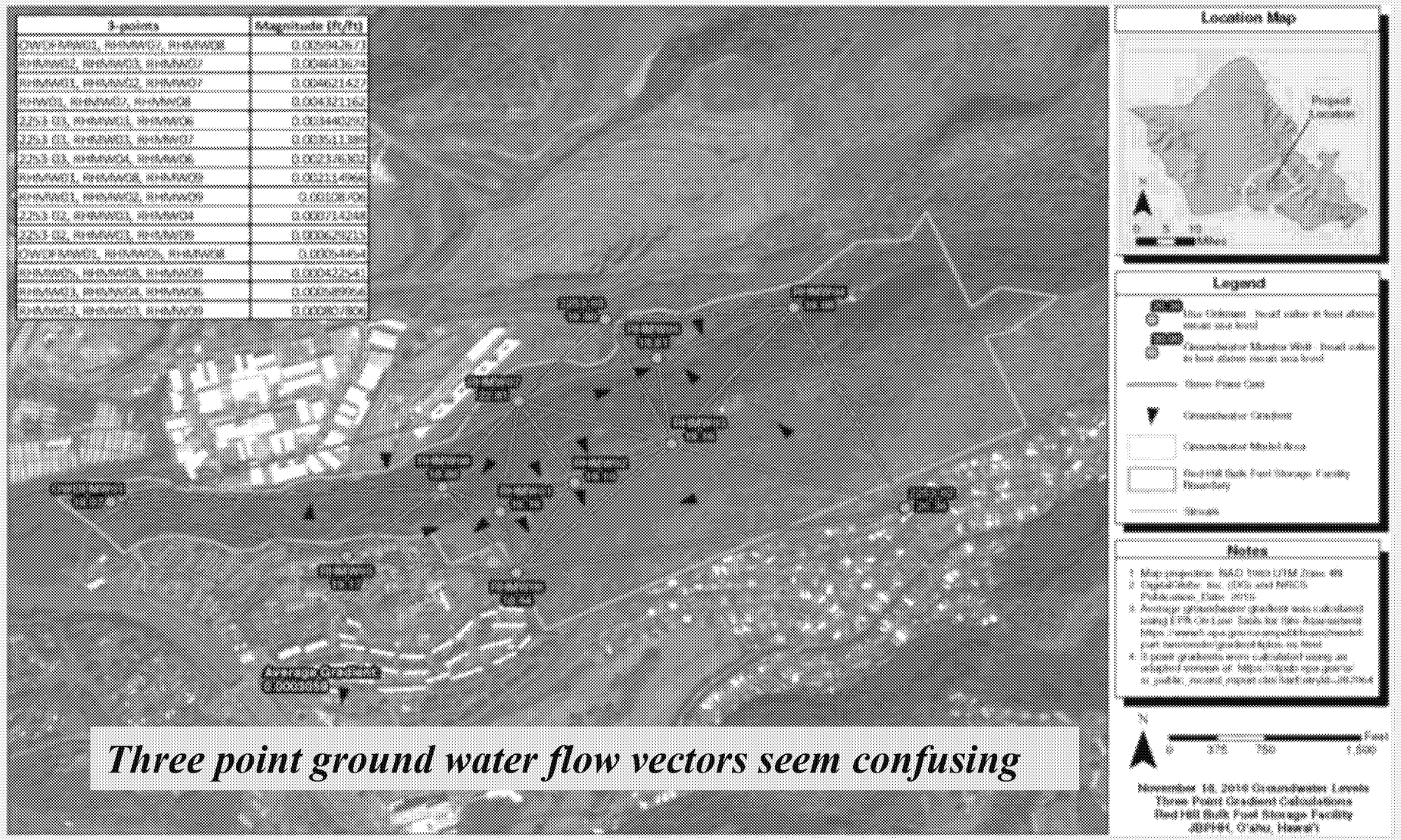
Lack of Verifiable Metrics



Reliability of GW Elevations

magnitude and direction, which are a primary objective for the model. However, the measurements of absolute water levels or gradients between well pairs may incur errors due to datum measurements and borehole gyroscopic tape corrections for the reasons previously discussed. The spring fluxes at Pearl Harbor Spring at Kalauao and Kalauao Spring were also calibration targets with target values shown in Table 3-2. Weighting on these targets was determined after preliminary PEST simulations such that the flux magnitudes did not overwhelm water level targets in the objective function. Finally, the extraction rates at pumping wells were also included in the PEST multi-objective function to ensure that pumping did not reduce with bottom-hole conditions during calibration.

NOVEMBER 2016 SYNOPTIC MONITORING GROUNDWATER GRADIENT FIGURE



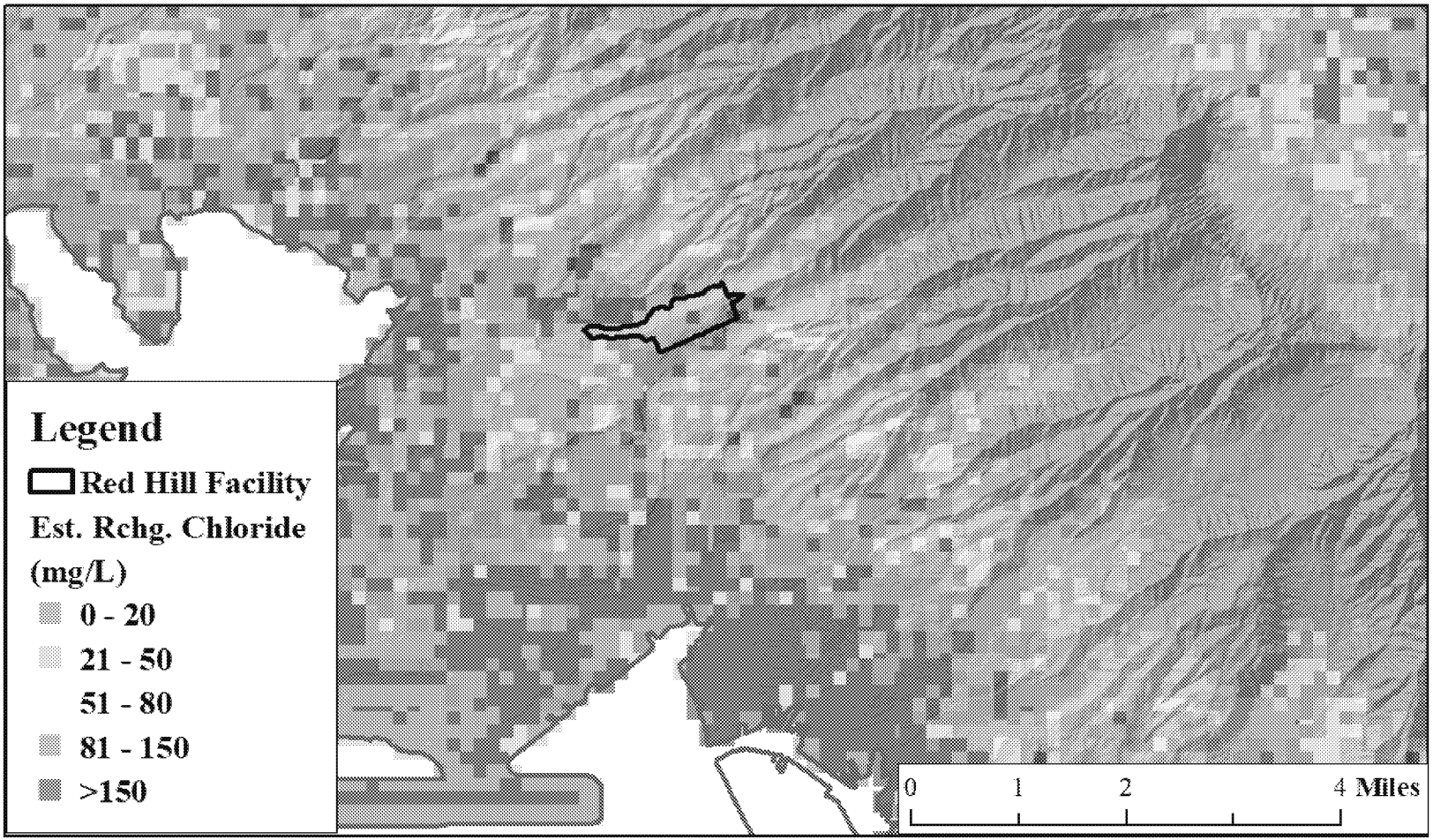
Alternative Metric

9. Groundwater Data

Chemistry shows indication of a poorly mixed system

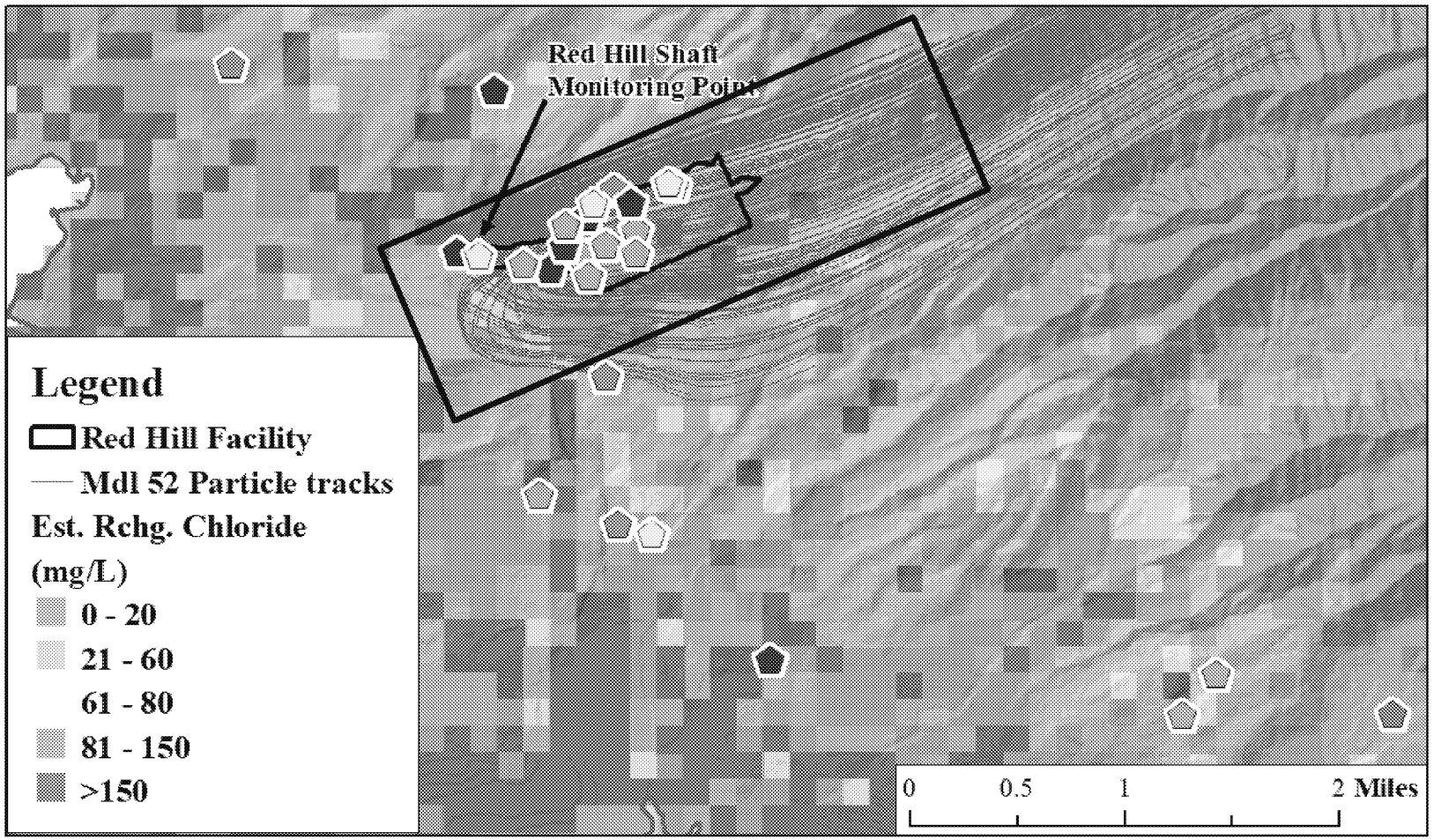
- Chloride conc. vary from ~40->1000 mg/L
- Southeast very different from northwest
- Northwest chlorides still highly variable
- A large flux of groundwater down the Red Hill ridge should show better mixing

Estimated Chloride Conc. in Recharge



$Recharge_{Cl} = 7.5*(Rain-Runoff)/Recharge$

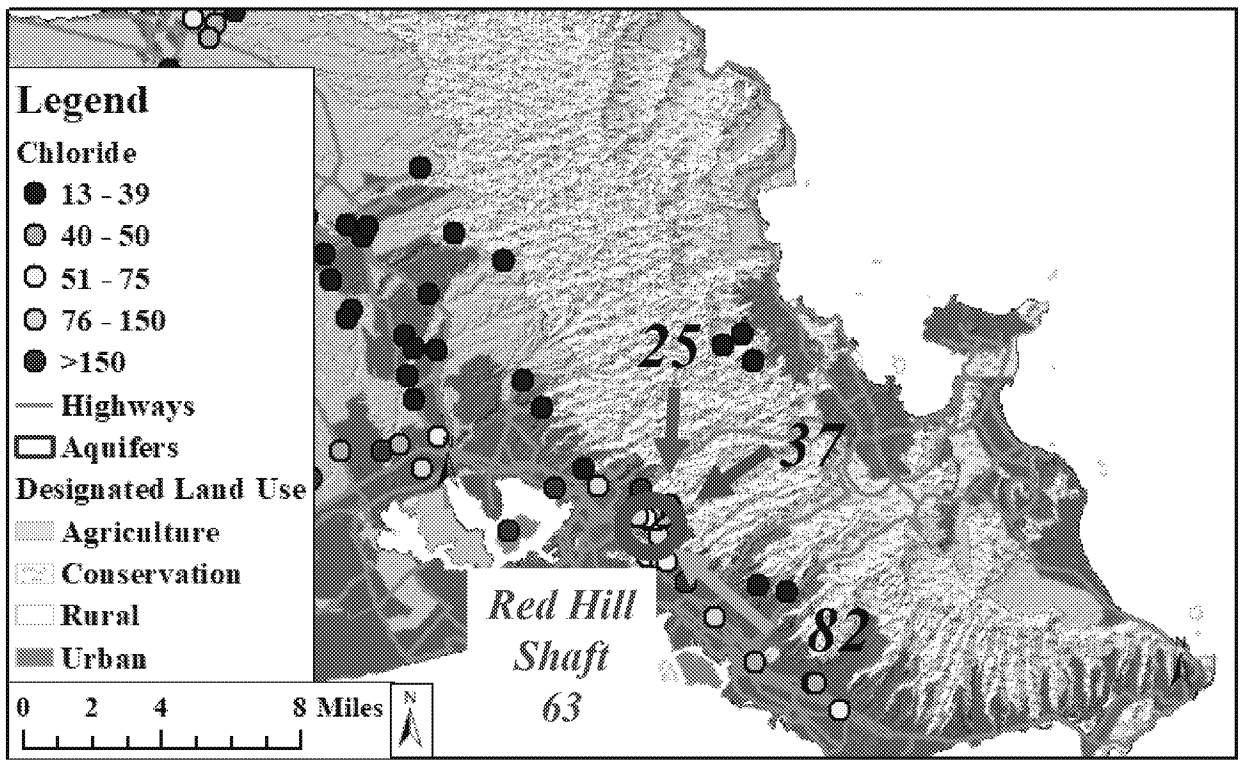
Lack of Verifiable Metrics

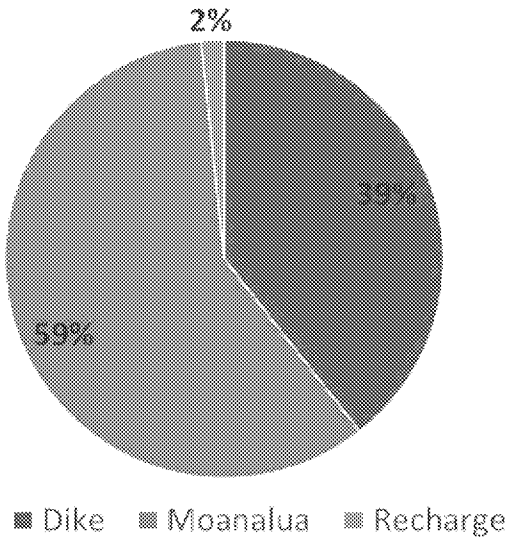


Flow model could be tested using the flow budget utility and representative values of groundwater chloride

Incorporating Geochemistry w/o Doing a Transport Model

- Mixing Equation
  - $C_{mix}=(C_1*Q_1+C_2*Q_2+C_3*Q_3)/(Q_1+Q_2+Q_3)$
- Inflow to Red Hill Shaft
  - Chloride concentration is weighted Cl sum from the source areas

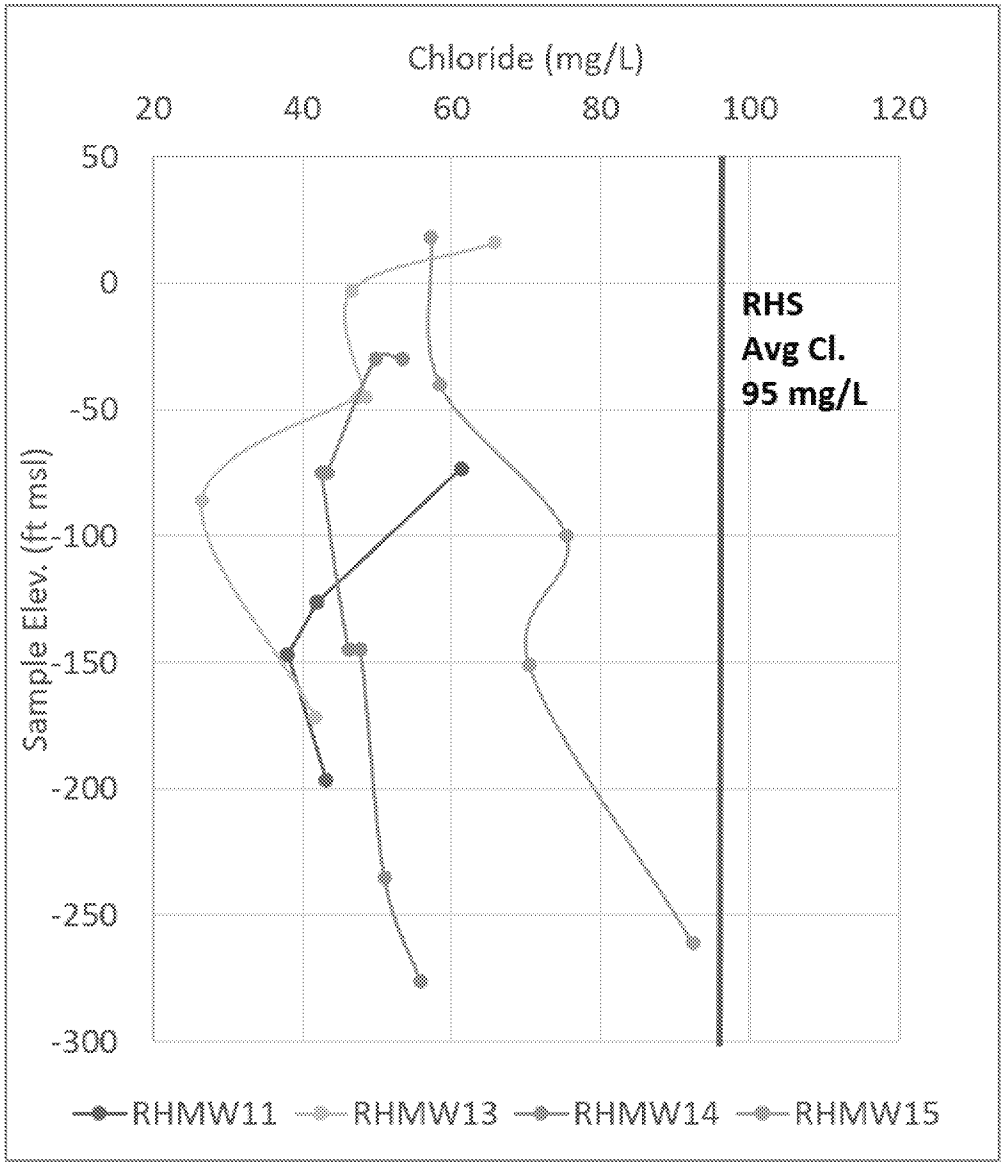




Numbers denote assumed chloride concentration

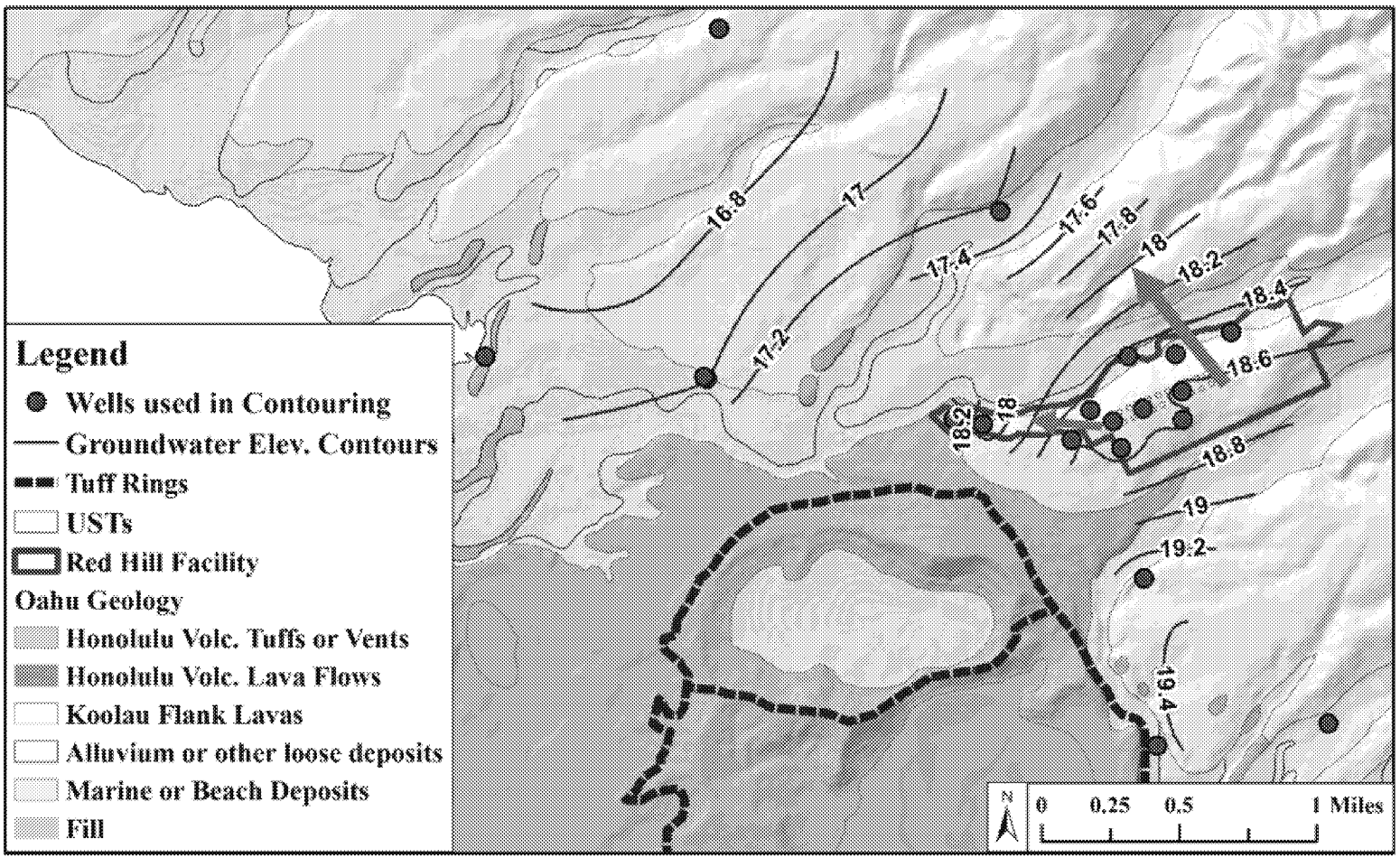
Westbay Well Chlorides

Constrain source area for chloride



- Upslope of the Red Hill Facility all Cl<< RHS Cl_{avg} of 95 mg/L
- Low Cl in RHMW11, 13, & 14 argue against up flow from HDMW2253 as the source of Cl
- In RHMW15 (near the east end of the RHS infiltration gallery) the chlorides start to approach RHS values **only** at the deepest sampling port (-260 ft msl)
  - However, water levels indicate a downward gradient

Regional groundwater elevation contours



Chloride concentrations could be better explained by the postulated ground water flow directions

THE END

- THE END

Techniques for Model Verification